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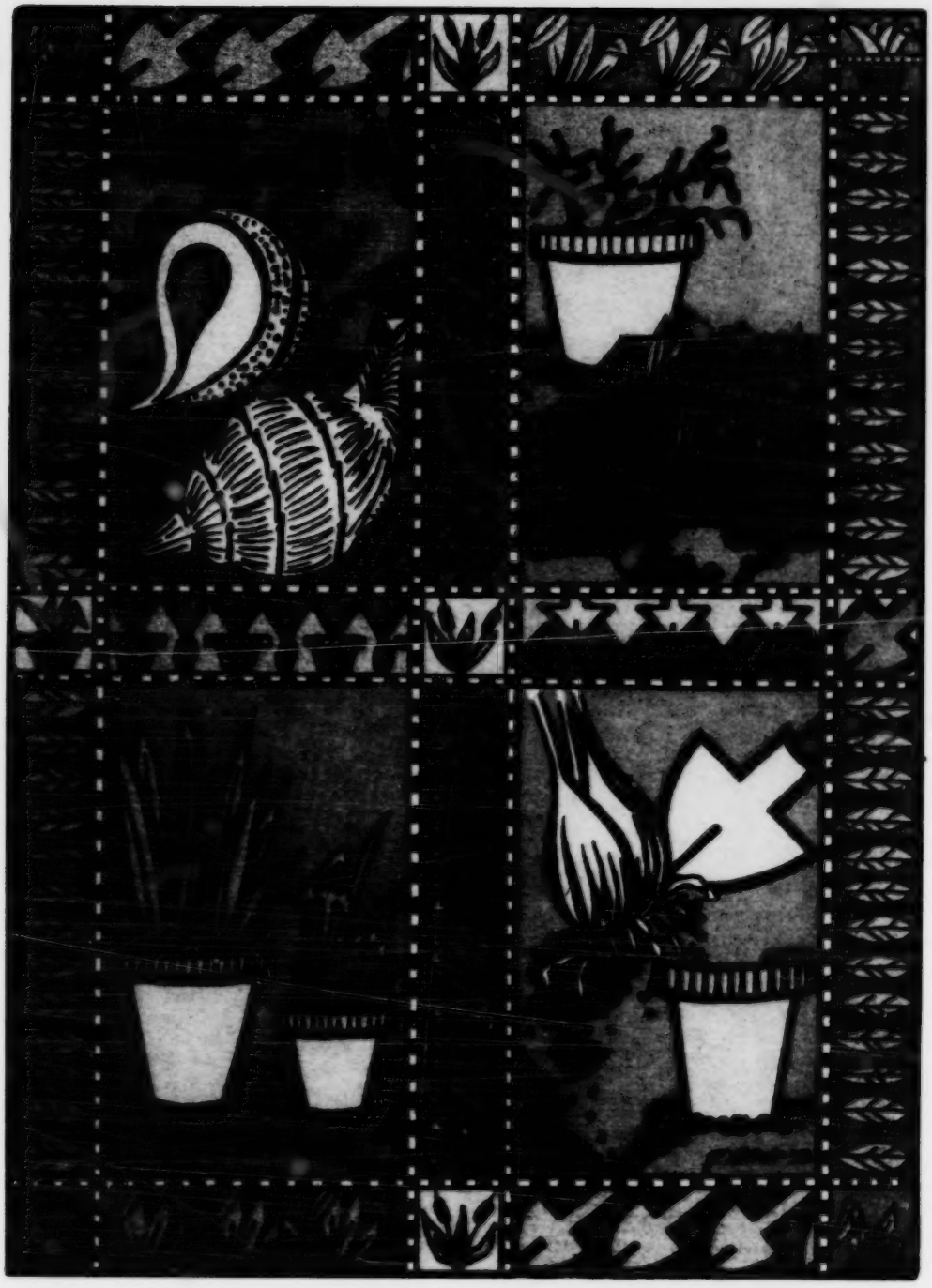

PLANTING THE SEED

A Guide to Establishing Aquatic Plants

Author:

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UNLIMITED SEED

A GUIDE TO ESTABLISHING AQUATIC PLANTS

Introduction

Wetland restoration projects have become an important part of conservation strategies within the Great Lakes Areas of Concern and at other identified locations throughout the Great Lakes basin. Benefits from these projects include: improvements to water quality, better fish and wildlife habitat, conservation of biodiversity, and a greater understanding and relationship with the natural environment. A key component of these restoration initiatives often involves establishing native aquatic plant communities.

Currently, the science of establishing aquatic vegetation in Canada is in its infancy with limited long-term results. Projects often move forward on a trial and error basis, while at the same time developing, demonstrating and modifying new restoration techniques. It is relatively easy to vegetate an area, but it is more difficult to protect plants from fluctuating water levels or a variety of herbivores. Part of the difficulty is that there are few references describing the Canadian experience in wetland restoration. This booklet has been compiled to provide an introductory guide to establishing aquatic plants in the Great Lakes basin.

Why Wetlands?

"A wetland is land that is seasonally or permanently covered by shallow water, as well as land where the water table is close to or at the surface. In either case, the presence of abundant water has caused the formation of hydric soils and favoured the dominance of either hydrophytic or water tolerant plants."[1] These unique areas represent a combination of terrestrial and aquatic characteristics, and are further categorized by type as marsh, swamp, fen and bog.

Wetlands represent one of the most important life support systems in the natural environment. Wetlands provide:

- *A water purification system...filtering contaminants, suspended particles and excessive nutrients, improving water quality and renewing water supplies.*
- *An irreplaceable habitat...nesting, feeding and staging ground for many species of waterfowl and other wildlife such as reptiles and amphibians.*
- *A high quality spawning and nursery area for many species of fish.*
- *Natural shoreline protection...protecting coastal areas from erosion.*
- *A reservoir...helping to control and reduce flooding through water storage and retention.*
- *A source of oxygen and water vapour...playing a vital role in the natural atmospheric and climatic cycles.*
- *Recreational activities...hiking, birdwatching and fishing.*

Despite the importance of wetlands they continue to be degraded and destroyed. Urban growth, industrial expansion, drainage for agriculture, new harbour facilities, and ineffective protection measures are all responsible for wetland loss. Wetland restoration is one strategy for maintaining and renewing wetland ecosystems. However, it is an imperfect process with many difficulties and restraints; moreover, restoration is not a substitute to wetland preservation. Wetlands take years to evolve, developing very complex hydrological and biological systems. For this reason, wetlands are not easily created or restored and every strategy to protect them must be used.

Planning a Restoration Project

"Ecological restoration is the process of renewing and maintaining ecosystem health."[4] This process is not a simple task. Successful projects require adequate background data, understanding of the project area, clear goals and objectives, long-term commitment (a minimum of five years) and some amount of luck. Projects must be carefully planned and well thought out. In some cases, the planning process will identify aquatic planting as inappropriate or that other mitigative measures must first be in place. Establishing aquatic plants is only one aspect of the wetland restoration process. For this reason, it is necessary to use this guide within a planning framework similar to that outlined in *Habitat Rehabilitation in the Great Lakes, Techniques for Enhancing Biodiversity*. The document outlines a number of important landscape planning issues to consider before embarking on a project:

Ducks Unlimited

A coastal marsh in southern Ontario.

I. *Past history and present condition of the restoration site.*

II. *Making sure rehabilitated or newly created habitat is connected.*

III. *Environmental contaminants and potential effects on the success and failure.*

IV. *Pre and post-project monitoring: learning from successes and failure.*

V. *Planting habitat restoration sites.*

VI. *The degree of management required to initiate the project and to maintain the site in the long run.*

As well, *Restoring Natural Habitats* provides information on developing a restoration strategy and identifies several design considerations for planning a wetland project. A few discussion topics include: how the project fits into a larger regional context, site evaluation and erosion control.

Early in the planning stage it is necessary to determine if the restoration site is contaminated by persistent toxic chemicals. This is important because, as well as improving water quality by filtering out contaminants, wetlands provide habitat for many species of fish and wildlife. Restoring polluted sites can result in the accumulation of chemicals in plants and other aquatic biota living at these new habitats. If contamination is identified, it may be best not to restore the area or to wait until remedial cleanup measures are undertaken.

How to Use This Guide

This guide outlines a number of issues and options to consider when establishing aquatic plants. It is mainly intended for marsh habitats; however, some discussion topics may be applicable to swamps. It does not pertain to fens or bogs.

The guide outlines how to develop a list of species for planting. Once this is determined, there is useful information on the following: appropriate sources for obtaining plant material; appropriate type of stock to select for planting; how to collect, process and propagate seed; and, how to plant and protect various plant species. In addition, there are a number of helpful hints and techniques for developing a successful vegetation project. Finally, a list of references and resources is provided for further information.

Establishing Wetland Vegetation

There are two approaches for establishing wetland vegetation: natural colonization and planting. The most appropriate or a combination of methods will be identified during the planning phase of the project. Natural colonization refers to the establishment of plants through the germination of existing seeds or those brought to the site naturally by wind, water or wildlife from nearby sources. Planting involves placing desirable species at a site.

Natural colonization is a viable method and in some cases it will occur relatively quickly. Annual species such as nut grass (*Cyperus* sp.) or pioneers like soft rush (*Juncus effusus*) can provide 100 per cent cover in three months if there are appropriate site conditions such as a drop in water levels leading to a wet meadow or exposure of mudflats during early spring. This method is a wise alternative to planting because it is very inexpensive and not as labour intensive. It is appropriate for areas that are difficult to plant or are relatively large in size. However, poor site conditions, little or no seed source and surrounding land uses (e.g., pollutants) can slow the rate of natural colonization and possibly lead to the invasion of undesirable species. Carp (*Cyprinus carpio*), muskrat (*Ondatra zibethicus*) and waterfowl feeding will also challenge this process. Under these circumstances planting may be the only viable option.

Developing a Plant List

Developing a plant list is one of the first tasks to complete before embarking on a wetland planting project. The selection of plants should reflect a native vegetation community of the local bioregion that is appropriate for a particular wetland type. This may involve some historical and local community research. Each project will have a unique plant list based on local environmental conditions and the desired outcome of the project. When developing a plant list, consider the following points.

MARSH VEGETATION FORMS

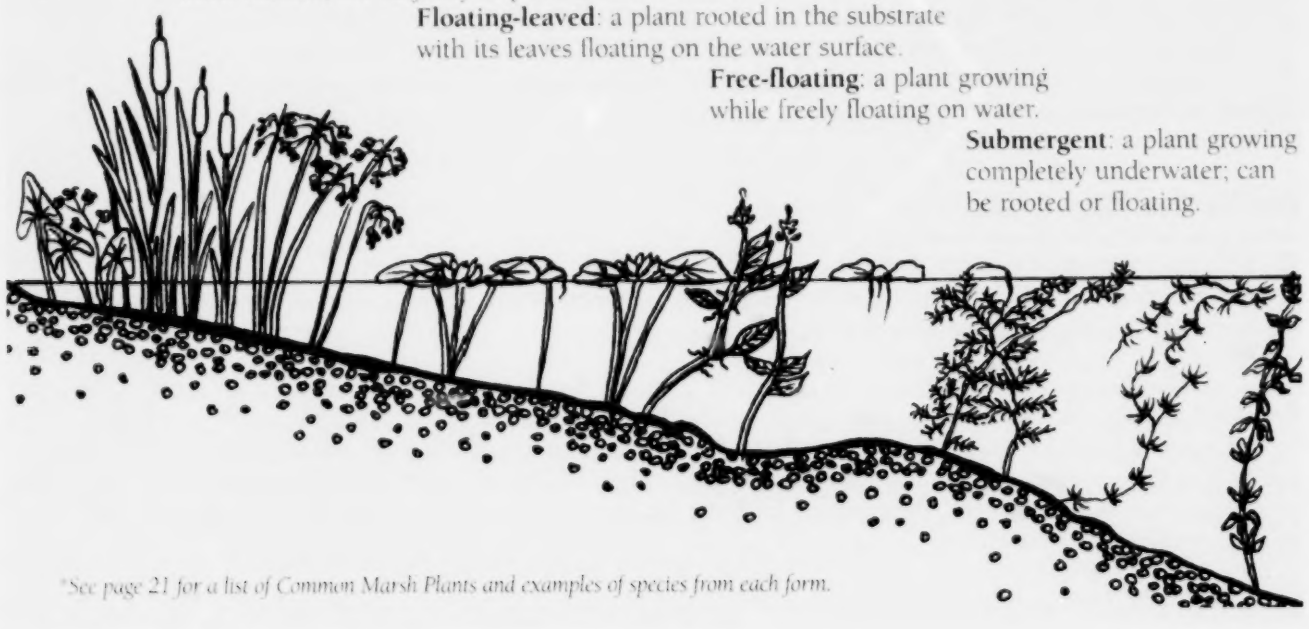
Before developing a plant list it is helpful to understand the different forms of plants growing in a marsh environment. Various forms include:

Emergent: a rooted plant growing up through the water surface; the majority of plant is above water.

Floating-leaved: a plant rooted in the substrate with its leaves floating on the water surface.

Free-floating: a plant growing while freely floating on water.

Submergent: a plant growing completely underwater; can be rooted or floating.



See page 21 for a list of Common Marsh Plants and examples of species from each form.

1. Goals and objectives

Plant lists will vary depending on the goals and objectives of a project. These may include establishing diverse plant communities, enhancing habitat for fish and wildlife, improving water quality and creating educational opportunities. As an example, improving water quality may involve planting species that can quickly stabilize substrate like cattails (*Typha* spp.) and bulrushes (*Scirpus* spp.). Developing educational opportunities may entail restoring or creating a variety of habitats. Restoring habitat for a particular bird species such as Sora (*Parzana carolina*), requires wild rice (*Zizania aquatica*), sedges (*Carex* spp.), grasses, smartweeds (*Polygonum* spp.) and bulrushes to provide food and cover.

2. Historic information

Historic plant inventories are a useful starting point when developing a plant list for restoration projects. These lists will give a good indication of the species and communities that used to exist or still occur at a site. Sources of historical information include: original land survey records from the Ontario Ministry of Natural Resources' Crown Survey Records; past studies from academic institutions or governmental agencies; historical manuscripts; aerial photography; local herbariums; and, records from local botanist and naturalist clubs.

3. Plantings should imitate local natural communities

Observe the community structure of native species growing at the project site. Also, pay close attention to the species composition: which species are dominant and where do they occur; what is their association with other species and at what percentage? This is a good way to select species and decide where they should be planted. If only a few species are present or the project involves creating a wetland, examine similar type wetlands in the area. Schedule visits to a number of wetlands at different times of the year to fully characterize potential natural communities. This will take into account short-term limiting factors such as scouring from high velocity flows after heavy rain or drying-out over the winter.

4. Native plants

Native plants are species that occur naturally in an area since the last glaciation and prior to European settlement. Species can be genetically differentiated across a range of spatial and environmental gradients (e.g., climate, soil, hydrology, topography). It is therefore important to select species that are native to the local region and of local source. The benefits of planting native species include:

- *Conservation of local genetic diversity.*
- *Adaptation and integration with local flora and fauna (e.g., ability to provide food, shelter).*
- *Improved growth, vigour and fertility.*
- *Increased survival rate in local environmental conditions.*
- *Reduced maintenance costs because these species are better adapted to site conditions.*

It can be difficult to differentiate between many species of wetland plants. When selecting native plants it is best to consult with a botanist to ensure the proper identification of all species.

Avoid selecting exotic plants. Some of these species can severely impact restoration activities by displacing native vegetation. It is a good idea to develop a list of local plants that distinguishes native from non-native species (refer to page 21 for a list of common exotic wetland plants). The publication *Invasive Plants of Natural Habitats in Canada* provides a comprehensive discussion on invasive wetland exotics.

EXOTIC AND INVASIVE PLANTS?

Exotic plants are not native. These species are largely present because of intentional or inadvertent human activities. Quite often exotic plants are introduced from other continents. Purple loosestrife (*Lythrum salicaria*), a common and familiar wetland exotic, was likely introduced to North America from foreign seed crops, livestock feed or more likely, the discharge of ship ballasts. Further spread of this species is linked to herbal use, garden plantings and inclusion in wildflower seed mixtures.

Some exotics are also invasive. Invasive refers to species that reproduce so aggressively they displace native vegetation resulting in a loss of floral and faunal habitat and species diversity. Invasive exotics such as purple loosestrife, Eurasian watermilfoil (*Myriophyllum spicatum*) and flowering-rush (*Butomus umbellatus*) can severely degrade wetlands by displacing native vegetation.

Some native species can also be invasive. Several cattail and bulrush species can rapidly take over an area. Their aggressive nature can be useful when trying to establish vegetation quickly. This can also be a problem when trying to develop a diverse community. The invasive nature of a plant should be considered before planting. *The Wetland Planting Guide for the Northeastern United States* describes several species that are possibly invasive.

5. Hydrology

This is the most critical factor to consider when selecting aquatic vegetation. Wetland hydrology deals with water regime characteristics such as water depth, flooding, water quality and flow. A typical plant list includes a range of species adapted to different water regimes. Water quality is particularly important. Certain native species may not tolerate degraded conditions. As an example, it would be very difficult to restore wild rice in areas with high turbidity, nutrient and pollution levels. It may be necessary to initially select a few hardy species that can quickly establish and tolerate poor water quality (e.g., bulrushes, cattails). In time, these plants will help create more suitable conditions for the natural colonization or planting of other species. *Techniques for Wildlife Habitat Management of Wetlands* discusses several physical and chemical tolerance levels for aquatic species.

6. Substrate

Soil texture, moisture-holding capacity, fertility, pH, salinity and contaminants will affect plant establishment and growth.[5] For instance, it may not be practical to select species such as arrowhead (*Sagittaria* spp.) or pickerelweed (*Pontederia cordata*) for areas with a soft unconsolidated substrate. These species are better suited for sites with firm substrate enabling plants to firmly root and not allow bareroot propagules or tubers to float away shortly after planting. A propagule is a segment of a plant used to vegetatively reproduce or propagate a species.

7. Growth Characteristics

Consider the following points when selecting plants:

Life expectancy (annual, perennial)

Annuals live for only one growing season and reproduce by seed. Annuals have a disadvantage in restoration because they die after the first year of growth, they may not hold soil over the winter season and their seeds may not germinate at the original planting site. As well, vacated spots created by annuals may allow exotic species to become established. However, annuals can provide short-term cover until a site can be planted with perennials. Perennials grow year after year at the same site. Perennials are advantageous because they can hold on to and expand from the original planting site.

Rate of plant establishment

If it is necessary to vegetate an area in a short period of time, it may be best to obtain species that spread quickly using rhizomes (e.g., cattail). This is often an important concern when selecting plants to stabilize substrate or prevent erosion.

Ability to reach suitable size in a reasonable time period
Many plants require a substantial amount of time to grow. Developing a sufficient root system can take several months, and is important for maintaining plant stability in areas with high wind and wave action, strong currents or ice movement. Slower growing plants should be planted earlier in the season to facilitate their establishment.

Resistance to herbivores
Some plants are more susceptible to herbivory than others. This is largely dependant on the site conditions and the type of herbivores present in the area. See the Protection of Plants section for further discussion.

Ability to propagate
Plants like giant bur-reed (*Sparganium curycarpum*) and sweet flag (*Acorus calamus*) can be difficult to propagate. They have low germination rates, special growth requirements, special stratification procedures and require more time and expertise to grow successfully. This affects the cost of the plant. Other factors that can increase costs include slow growth rates, rarity of the plant in nature, lack of seed producing plants, difficulty of collection (e.g., submerged seed heads), and processing difficulty. Plants that are easy to propagate have high germination rates and fast rates of growth (e.g., cattail, rush (*Juncus* spp.), bulrush).

Competition with other plantings and naturally occurring species
It may be inappropriate to plant a dominating species like cattail with other less aggressive species such as rushes or sedges. Cattails tend to takeover when competing with other plants for space and resources. However, cattails are an ideal species to plant in many situations because they are easy to propagate, spread quickly and are tolerant of poor water conditions.

8. Availability

With increasing interest in wetland restoration, several nurseries now have a wide selection of native aquatic plants grown from local sources. It is impossible however, for a nursery to carry every species, so it is better to collect seeds and have them grown by a local nursery under contract. This will ensure the availability of appropriate species and is more economical. The following section provides a further explanation of other sources for plant material.

Obtaining Plant Material

After deciding which species to plant, the next thing to consider is where to obtain them. There are two main sources of plant material. Collecting from a donor site or buying directly from a commercial supplier or nursery. A combination of both options works best.

Donor Site (within study site or similar local habitats):

Obtaining plant material from within the study site and from similar local habitats is most desirable. This includes transplanting fully grown plants or collecting seeds, tubers, rhizomes or cuttings. These plants are adapted to local environmental conditions and are more likely to establish successfully. For some species, pollen and seeds may travel so far that there is little genetic difference between plants of the same species that are thousands of kilometres apart. However, it is also true that even nearby populations can become somewhat distinct in ways that allow them to survive in slightly different conditions including water depth, soil type, micro climate or disease tolerance. It is difficult to place an exact measurement on the distance from the restoration site for obtaining material, but as a guide, acquire material from areas that are as close as possible. Try to remain within a 10 to 100 kilometre radius. Overall, native plant material should be locally adapted and provide as much genetic diversity as possible. ***Keep in mind that the collection of wild plant material, particularly fully grown plants, can negatively affect the donor wetland***. The next section, Selecting Plant Stock, lists a number of collection guidelines.

CLASSROOM PROPAGATION PROGRAM

Another method of obtaining aquatic plants is to develop a classroom propagation program where students from local schools grow aquatic plants from seed. This is an effective way of supplying a large number of plants at a reasonable cost and contributes to educational programming. For this program to be successful, there must be a least 10 to 12 months of careful planning. The first step is to collect seeds from nearby wetlands. Researchers have found that certain plant species grow better than others in a classroom setting. Some of these include cattail, soft-stemmed bulrush (*Scirpus validis*), black bulrush (*Scirpus atrovirens*), joe-pye weed (*Eupatorium maculatum*) and white boneset (*Eupatorium perfoliatum*). The seeds are then cleaned and undergo several months of stratification (cold storage). The section on Seed Collection, Cleaning and Propagation provides detailed information on seed processing procedures. Each classroom receives a planting kit which includes an instruction manual, two dish-pans, several potting trays, seeds and a small bag of soil. The kits are distributed sometime in February or March.

Patricia Clowe-Fraser

Students from Sam Sherratt Public School with their planting kits.

After six to 14 weeks of growth, teachers return the seedlings to a greenhouse for storage until planting. With each kit, it is possible to grow at least 50 plants. It is not uncommon to grow four to seven thousand plants from 200 kits. The number of plants returned from the classrooms tends to vary depending upon the viability of the seeds and the conditions under which the plants are grown. This type of program helps to promote wetland conservation, as well as provide students with hands-on environmental experience. It also provides an opportunity for students to plant their own seedlings, giving them a personal connection to the overall restoration project.

For further information on this type of program, please contact:

Bay Area Restoration Council (BARC), Life Sciences Building, McMaster University, Hamilton, Ontario, L8S 4K1. Tel: (905) 525-9140, ext. 27405. Email: barc@mcmail.cis.mcmaster.ca

Gord MacPherson, Toronto and Region Conservation Authority, 5 Shoreham Drive, Downsview, Ontario, M3N 1S4. Tel: (416) 661-6600, ext. 246

Patricia Lowe, Oshawa Second Marsh Project Coordinator. Central Lake Ontario Conservation Authority, 100 Whiting Avenue, Oshawa, Ontario, L1H 3T3. Tel: (905) 579-0411.

Nurseries

There are several advantages to using nurseries, such as their ability to provide quality healthy plants, to supply large quantities, and to deliver materials in suitable planting condition.[4] In addition, assuming that seeds or stock plants are collected following good conservation practices, there will be minimal negative affects on natural habitats. Several nurseries are now set-up to supply aquatic plants grown from locally collected seeds (refer to page 22 for a list of native aquatic plant growers). Issues to consider when dealing with nurseries:

A sufficient amount of lead time is necessary for ordering plants.

It is not uncommon for restoration projects to use 20,000 plants during the planting season; therefore, substantial lead time is required to collect and propagate material. At least one year of planning and preparation is necessary.

Determine the origin of the plant material.

Does the grower collect from natural or managed ponds, grow from local seed sources or import from distant suppliers? Remember, the project should be using local native plant material. As well, be sure to ask if the grower uses cloning techniques as a method of propagating plants. Cloning is the propagation of a group of plants from a single individual. This can reduce the genetic diversity of a plant population. Genetic diversity is important because it enables a population of individuals to adapt to a range of ecological conditions (e.g., drought, high water levels, diseases).

Do not use imported plants.

It is best not to import plants because there is a risk of importing exotic species or faunal pests. As well, plants may be detained at the import terminal for a long period of time, which will severely affect their health and likelihood of survival.

Selecting Plant Stock

There are several forms of plant stock to choose from when vegetating a wetland. The chart on pages 10 and 11 outlines the type of stock available from nurseries and wetlands (donor sites). It provides a starting point when deciding which type of material to use. It also lists collection and planting times, relative cost, relative survival and success, negative collection effect (relative negative effect on a donor site associated with the collection of plant material) and a discussion of the advantages and disadvantages of each stock type. It may be best to initially use several types to see which works best at the project site.

When obtaining stock from natural wetlands, consider the following:

- *Collect only species that are common to dominant.*
- *Check roadside ditches as a preferred donor site before collecting from a wetland.*
- *Do not collect plant material from wetlands with rare, threatened or endangered species.*
- *Collect only a small portion of species and individuals from a single wetland community.*
- *Do not collect plant species without landowner permission.*

It is advisable to contact the Ontario Ministry of Natural Resources, a Conservation Authority or an organization familiar with these procedures (e.g., Royal Botanical Gardens, P.O. Box 399, 680 Plains Road West, Hamilton, Ontario, L8N 3H8. Tel: (905) 527-1158) before obtaining plant material. This will help to ensure that collection activities do not adversely affect wetlands.

It is also important to consider that people from several different projects may be collecting plant stock from the same wetland. This can severely deplete the reproduction capability of plants, especially if this occurs on a yearly basis. To limit this problem, try to stay informed of other projects in the area. Contact local government organizations and naturalist clubs for assistance in identifying these projects. As well, look for signs that collections have already taken place such as a lack of seeds or cavities depicting transplanting. If these signs are found, move along to another site. Ideally, after a few years projects should be able to supply their own plant material. Remember that the uprooting of plants can create an opportunity for exotic species to become established. Purple loosestrife can take advantage of disturbed sites caused by transplanting activities.

Planting Stock

Plant Stock	Description	Collection Time	Planting Time	Relative Cost	Relative Survival Success
Seed	A propagule with a protective outer coat. Mainly available from a donor wetland.	• early summer to late autumn	• spring or autumn	• lowest	• low
Tuber	Large, swollen underground stems that provide food storage for the plant.* Available from a wetland and nursery.	• spring or autumn	• early spring or late autumn	• moderate	• high
Rhizome or rootstock	Underground stems that usually grow horizontal to the surface, providing food storage for the plant.* Available from a wetland and nursery.	• spring or autumn	• early spring or late autumn	• moderate	• high
Container (propagated seedling)	Young plants that have their roots surrounded by soil in a peat, fibre or plastic pot. Available from nurseries.	• not applicable	• spring or summer	• high	• high
Bare root	Young plants with very little or no soil surrounding roots. Available from nurseries.	• spring to mid-summer	• spring or summer	• intermediate	• moderate
Transplants	A single or group of plants (including soil and root systems) dug from one wetland area and planted in another.	• no restriction	• spring, summer or autumn	• low if done by volunteers, high if paid labour.	• high

* *Information for this table was adapted with permission from Environmental Concern Inc. and the U.S. Army Engineer Waterways Experiment Station.*

Negative Collection Effect	Advantages	Disadvantages
• low	• minimal planting effort, can be broadcast or incorporated into soil mixtures • low labour and costs • suitable for large sites • can be stored for several years • increases genetic diversity	• wide range of viability, reliability and success • restricted harvest and planting time • special storage requirements (i.e., no pests, cold, wet) • long stratification period for some species • predation of seed • low germination rates for some species • seed can easily wash away from planting site
• high	• minimal planting effort	• large tubers difficult to extract from soil • susceptible to washout • some species susceptible to predation • reduced genetic diversity, may be clonal • difficult to obtain a large number of plants without causing excess damage
• high	• minimal planting effort • maximizes use of plant materials	• susceptible to washout • generally requires cultivation • reduced genetic diversity, may be clonal • difficult to obtain a large number of plants without causing excess damage
• low • low	• easy to plant, ideal for volunteers • can store in greenhouse or nursery • allows flexibility in coordinating project design and planting • high level of genetic diversity if seeds are collected properly • bare root material is easier to handle and transport	• requires planning and preparing in advance • susceptible to trampling and predation by wildlife
• high	• rapid establishment • increases probability of success • stabilizes soil rapidly	• very labour intensive • may be difficult to dig, transport and plant • causes damage to the donor site • difficult to obtain a large number of plants without causing excess damage

Note: All information is highly species dependent.

Seed Collection, Cleaning and Propagation

To minimize the negative effects of collecting plant material, propagate plants from seed. Collecting seed, when done properly, has few long or short-term effects on the donor site, and offers the best chance for success. It is important to realize that seed collection can have severe consequences if done improperly. This is especially true when dealing with annuals or species that produce few seeds or seed only infrequently. Consider the following when collecting seed:

- *Collect from many plants over a large area.*
- *Collect no more than 50 per cent of the seed of each plant.*
- *Collect no more than 10 per cent of seeds from any given site, even less if planning to collect from the same place next year.*
- *Collect seed from a number of different plants ranging in size and habitat location.*

Also, review the section on Selecting Plant Stock before collecting seed.

Seed Collection

Most wetland species release seed in the late summer and autumn, with some notable exceptions. For some species the window of opportunity for collecting is quite small (two weeks), while others can be much longer (three to four months). It is important that seeds not be collected until they are nearly ripe since immature seeds have reduced viability. After developing a checklist of plants for the project, conduct a literature search for each species to determine what time of year the seeds should be collected and how they should be stored to obtain maximum germination (see Seed Processing and Propogation chart).

Kathy Magris

Collection of softstem bulrush seeds.

Before collecting seed the following items should be prepared:

- *A paper bag to store the seeds while collecting (plastic gets too hot).*
- *A cool dry protected place to clean the seeds.*
- *Seed cleaning equipment (e.g., sieves)*
- *Containers that will keep seeds moist while stored (e.g., margarine tub)*
- *A fridge to keep the seeds between 1°C–5°C for several months or until ready to sow.*

When transporting seeds from the collection site be sure to keep them as cool as possible. High temperatures can reduce the viability of the seeds.

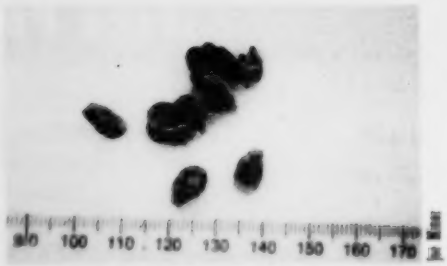
Cleaning

Seeds do not have to be cleaned before storage, but it is a good idea. Separating flower parts from the seed makes it easier to store and sow them. It also tends to limit the amount of mould that will grow during storage. Many species will require a day or two of drying before the seeds can be separated from other floral parts. This is easily done by spreading the flowers over newspaper on a table top. Make sure the area does not reach high temperatures on sunny windless days as this will adversely affect viability of the seeds. This area will also need to be protected from strong winds as some wetland seeds are quite small and easily scattered. After drying, it is much easier to separate the seeds from the inflorescence (cluster of flowers) by rubbing a handful between your hands or shaking them vigorously in a bag. Different species will require different treatments to separate the seed (see Seed Processing and Propagation chart).

Joe Miner

A sieve and several species of seeds stored in sealable containers.

The second step is to sift out the seeds from the rest of the floral parts. This is best done by using different sized sieves. In some cases, it is possible to separate the seeds by allowing a light breeze to blow away the lighter chaff (external husk of seed). Placing the seeds on a table in front of a fan also works well. Most of the floral parts will be removed by using a combination of these methods. After cleaning, place the dry seeds in a sealable container, fill with water (only if necessary, see Seed Processing and Propagation chart) to the top of the seeds and shake thoroughly. Then place the container in a refrigerator at 3°C. Mould may appear on seeds that are stored in sealed containers; however, this does not pose a serious problem because mould will only affect the top layer (top two centimetres). This top layer should be discarded because mould reduces the viability of the seeds. Be sure to collect enough seeds to compensate for those that are lost to mould. To avoid mould, use a perforated container, but care must be taken to ensure the seeds do not dry out. This approach requires constant monitoring. Both methods are acceptable and have advantages and disadvantages.



Swamp milkweed (*Asclepias incarnata*)

The seeds of wetland plants need several months of stratification in cold, damp conditions. Stratification mimics winter conditions that seeds must endure before germination will occur. If this is not done, many seeds will not germinate. Most species will not germinate if they freeze or reach temperatures over 45°C.

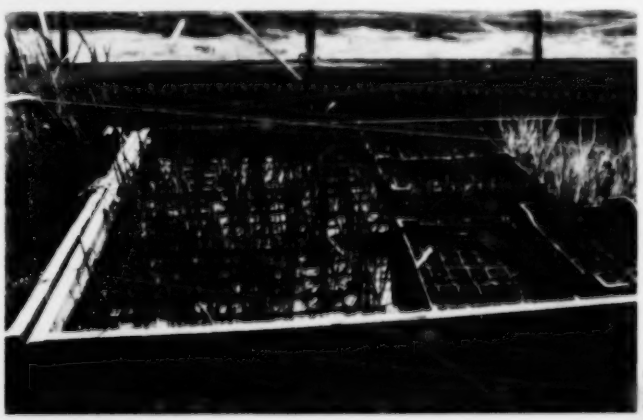
Germination

With the use of a greenhouse it is possible to begin growing some species before the onset of spring; however, many species will not grow very well until the longer days of February and March. This is likely due to an increase in light intensity as well as day-length. When using artificial lighting, use both incandescent and fluorescent tubes or grow bulbs to give a broad spectrum of light.

Most wetland plants, excluding submerged and floating-leaved aquatics, can be grown quite easily in conventional greenhouse containers. Before the seeds are sown, they should be rinsed and dried. Seedling flats work well to start plants. After they reach a size of two to five centimetres, transplant them to small pots (9 - 10 centimetres). High humidity will increase germination and reduce the need for watering. Clear plastic humidity domes are available from greenhouse supply companies. These should be kept in place until the seedlings are well established. It is also necessary to keep the soil saturated, which is easily accomplished by placing the pots in plastic trays. If using potting soil or black loam, it is not necessary to use fertilizer unless the plants are kept in the nursery for more than two months.

High humidity and saturated soils tend to encourage mould and algae growth. Use clean pots and accessories to reduce these problems. Disease will be reduced by using a sterile soil mix and maintaining an air current through the greenhouse. The most common animal pests encountered are aphids and fungus gnats. There are biological agents (e.g., lady bugs) available to combat these insects.

The Seed Processing and Propagation chart gives some examples of how to sow and store seeds. The "Days" column indicates the minimum number of days for seed stratification. Stratifying seeds for a shorter period of time than indicated may result in poor germination. After germination the seedlings should grow at the nursery for approximately three to four months or until a sufficient root system has developed. This usually occurs when the plant reaches a height of at least 10–15 centimetres.


Aquatic plants at a nursery.

Seed Processsing and Propagation

SPECIES	REQUIREMENTS	stored in refrigerator at 3°C			
		DRY	DAMP	IN WATER	DAYS (MINIMUM)
cattails (Typha spp.).	Collect whole cobs after frost. Store dry and intact. Seeds can be separated in water using a blender (seeds will settle to bottom) **OR** gently twist cob over the soil to loosen fluff (seeds). Cover with a very *thin*, even layer of soil or sprinkle with water to obtain seed/soil contact.	✖			90
giant bur-reed (Sparganium eurycarpum)	Collect when heads begin to fall apart. Heads will twist apart and there is no need to clean seeds. Cover with a *thin*, even layer of soil. Germination can be increased by removing the micropylar cap (top of the seed) with a sharp razor or knife. Seeds can also be broadcast directly onto the restoration site and raked into the soil. It is quite common to obtain only three to five per cent germination.			✖	unknown
common arrowhead (Sagittaria latifolia)	Collect when heads turn brown and begin to fall apart. Germination is sporadic. Sow on surface or under *thin* layer of soil. Fertilize plants well.		✖	✖	120
water plantain (Alisma plantago-aquatica)	Collect when heads turn brown and begin to fall apart. They germinate well on surface or under a *thin* layer of soil. Seedlings grow best in shallow water.		✖		90
softstem bulrush (Scirpus validus)	Collect when seeds turn black. Separate by rubbing dry flowers between hands. Sieve aperture of 20 micrometres and blowing fan will remove most of the chaff. Sow on surface.		✖	✖	120
black bulrush (Scirpus atrovirens)	Collect when seeds darken. Loosen seeds from flowers by rubbing between hands. Seed is tiny and may not separate from chaff. Inflorescence may produce bulblets which can be planted. Mix seeds with equal amount of sand to avoid sowing too densely. Sow on surface.		✖		90
sedges (Carex spp.)	Collect by stripping inflorescence as it begins to fall apart. Separate by rubbing. No need to remove perigynium (sac around seed). Some species flower early and disappear quickly. Cover with *thin* layer of soil.		✖		60
rushes (Juncus spp.)	Collect slightly before capsules dry. Tiny seeds, separate by rubbing dry capsules between fingers or shaking vigorously in glass jar. To avoid sowing too densely, mix at ratio of 1 (seeds): 3 (sand) and sprinkle over surface of soil.		✖		100
wild blue flag (Iris versicolor)	Collect when pods dehisce (split open). Seeds easily picked out. Seeds do not need cleaning. Cover with up to 1 centimetre of soil.		✖	✖	120
swamp milkweed (Asclepias incarnata)	Collect when pods dehisce. Sow on surface or cover with a *thin* layer of soil. Collect when seeds begin to dry.	✖			none
joe-pye weed & white boneset (Eupatorium maculatum & E. perfoliatum)	Collect when seeds begin to dry. No domancy period, but germination in enhanced by 90 days of moist stratification. Sow on surface.		✖	✖	90
speckled alder (Alnus rugosa)	Collect current-year cones any time over the winter. Separate by crushing cones between fingers. Sow on the surface of soil.	✖			90
water willow (Decodon verticillatus)	Collect when capsules dehisce and leaves turn red. Remove seeds by breaking capsule open. Will obtain moderate germination after 90 days, but germinates best after 18 months cold storage. Sow on surface.		✖	✖	1 yr+
blue vervain (Verbena hastata)	Collect by stripping inflorescence after frost. No need to clean seeds. Sow on surface or cover with *thin* layer of soil.		✖		60

Planting

Site conditions play a significant role in plant establishment. As noted earlier, wetland hydrology and substrate are very important. Aquatic plants adapt to certain water depths, and durations and frequencies of flooding. As an example, a submergent species such as tape grass (*Vallisneria americana*) requires permanently inundated conditions while an emergent such as Canada bluestem (*Calamagrostis canadensis*) prefers seasonally or regularly inundated to saturated conditions. When planting, it is necessary to match a species with the appropriate water regime. *A Wetland Planting Guide for the Northeastern United States* and *Techniques for Wildlife Habitat Management of Wetlands* outline water regime requirements for a number of aquatic plants.

If existing conditions are not conducive to supporting aquatic plants they may have to be altered before or concurrently with plantings. This can involve establishing appropriate water depths through digging or dredging or improving substrate conditions. At Second Marsh in Oshawa, Ontario, an unconsolidated silty-clay substrate made it difficult to walk and plant emergent bare root propagules. To address this problem, the planting area was stabilized by placing large mats of Geocoir fabric on top of the sediment; this organic fabric also protects root systems from herbivory. Keep in mind that natural or human induced changes in water levels can affect planting success. High water levels can impede emergent plant establishment, while lower levels can facilitate planting success.

Lorie Bampton

A volunteer preparing bare root plants.

Timing is everything. Although planting can be successful at any time of the year, earlier planting increases chances of success. Planting in the mid to late spring is ideal because it gives the plants a long growing season and provides lots of time for both root and shoot growth. Planting later than the middle of August results in small plants with minimal root growth. This can cause problems since many of the rhizomes of wetland plants are somewhat buoyant and dislodge easily in loose soils. Plants that are not well rooted when spring floods occur are more prone to being washed away. For this reason, it is also risky to plant dormant roots in the early spring and late autumn. However, at these times it is easier to handle and plant dormant roots and therefore if the conditions permit (heavy soils in areas not susceptible to excess flooding), this option is most economical. Also, consider cutting emergent plants close to ground level when planting late in the growing season (late summer or autumn). This will help prevent the removal of plants from ice movement.

There is also the question of which species to plant first. Some species (pioneers) are better suited to growing in newly disturbed sites and will be taken over later by more dominant species. It may be a good idea to start with these species because they tend to establish themselves quickly and stabilize the substrate.

When plant material arrives at the site it should be planted as soon as possible. If this is not feasible, store the material in the shade to keep it cool and moist.

Techniques

Planting techniques will vary with the species, the type of plant material and the planting site. Become familiar with the growth habit of the species being planted. Does it grow in monotypic stands, scattered clumps or individually? These characteristics will help in deciding how much space to leave between each plant. Keep in mind that the distance between each plant will affect the amount of time a species takes to fully cover an area. It will take a short period of time for plants to cover an area if they are placed closer together; however, this requires the use of more plants and leads to an increase in costs.

Plants with fast growth rates or the ability to spread quickly using rhizomes or rootstocks can be planted farther apart. Planting at a standard density of 0.5 to 1 metre centres is suitable for most plants. Plant spacing and growth rate characteristics for a number of wetland species are detailed in the *Wetland Planting Guide for the Northeastern United States*. It is quite possible that the original layout or design of the plantings will change over time as conditions at the site and the adaptive nature of each plant will ultimately decide the composition of the vegetation community. Also, most plants (excluding submergents) must have a portion of their stems (green part) above the water line to grow.

Additional information on planting techniques is available from several books (see the asterisk * in the Reference and Resource sections). When planting in and around water, safety is particularly important. Always plant in teams of at least two or more, wear suitable clothing and have plenty of liquid on warm summer days.

Direct Seeding

Consider the possibility of seeding directly onto the site. Although seed germination can be unpredictable, it is very cost effective and is one method of increasing the diversity of species without the cost of buying relatively expensive plants. The same consideration is needed to determine the best locations and method to sow seeds as is used in a planting project. Remember that many seeds are buoyant or wind dispersed, and care must be taken to ensure that the seeds come in contact with the soil. Seeding is most successful in the early summer after water levels and spring storms have subsided. If there is exceptionally dry hot weather after seeding, it may be necessary to water the area.

Transplanting

Transplanting involves collecting seedlings, single or clumps of adult plants, or rhizome sections from a donor wetland and planting them directly into a new site. It is best to transplant species in clumps with numerous stems and soil surrounding their roots.[10] This will help weigh down the plant and provide a stable base for the root mass. Also, be sure there are no exotic species present in the soil. Another approach involves placing the roots and substrate of a plant in a small burlap bag. The bag is tied at the top to contain the plant and has small incisions along the bottom to facilitate root growth.[11] This helps contain the root and soil, and weigh down the plant. Placing a stone in the bag will provide additional weight for the plant.

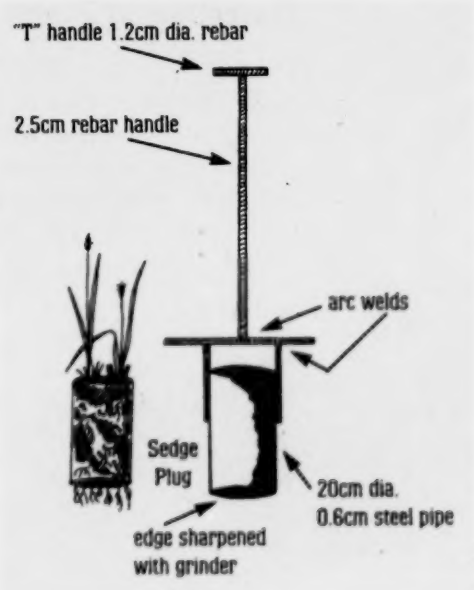
Andy Kapen

Transplanting cattails.

Transplants can be removed by hand or shovel. A shovel works best for plants with dense root systems (e.g., cattail). Place submergents, floating-leaved and free-floating plants in a container with water when transporting them to the planting site; some emergent species (e.g., cattail, giant bur-reed, bulrush) can be transported without water. Try placing transplants in similar water regime and substrate conditions, as this will help them adapt to their new environment. All plants should be planted as soon as possible. Leave 95 per cent or more of the donor vegetation patch to regenerate the site. Whenever possible, salvage plant material from a wetland that is facing destruction or when plans call for the removal of existing vegetation from within the project site (e.g., to change flow characteristics). If the addition of organic substrate is part of the design, consider using local sources, as seeds within the soil mixture

will be local in origin. *Restoring Natural Habitats* provides a further overview of transplanting aquatic macrophytes. This method is well suited to small restoration projects; however, for larger areas **it is best to collect seeds and grow them at a nursery**.

The plug cutter is an effective tool for obtaining transplant plugs. It is similar in design to a golf course cup-cutter and is made out of rebar and a metal cylinder. The cylinder is welded to the lower end of a shovel-like rebar handle. The bottom of the cylinder has a sharpened edge for cutting through plant roots. It is relatively easy to make and use. First the leaves and stems of an aquatic plant are pulled through the metal cylinder. The cylinder is then pushed down into the substrate cutting through the root mass. The plant remains safely inside the cylinder when the plug cutter is lifted out. Transplant plugs can then be placed on a tray for transport to the planting site. The cutter is useful for a number of plants including cattails, sedges and rushes.



Jim Collis

Tubers, Rhizomes and Rootstocks

Dormant roots (tubers, rhizomes, rootstocks) must be securely planted. Dig a hole with a shovel, bare hand or by pounding holes in the sediment with a stake. Push the root into the hole approximately five centimetres below the surface. Make sure to firmly pack soil over top of the root. When planting dormant roots at the end of the growing season, some species (e.g.,cattail, bulrush) will require the old stalk to remain above the water surface to allow for respiration.

Container and Bareroot Plants

Ensure that container and bareroot materials are firmly planted. Again, they should be planted at least five centimetres into the sediment. This is very important when working in unconsolidated sediment and if the new plants will be inundated and exposed to wind. It is a good idea to trim the plant to 15 centimetres in height before planting. This will help the plant avoid damage from wind and wave action and reduce stress.

Dewatering

Dewatering or drawdown focuses on removing water from some area within a wetland to promote plant growth. As water levels drop, mudflats become exposed and the wetland begins to dry. This dryer environment provides more ideal conditions for seedbank germination and plant growth. The resulting plant community will depend on the species of seed present in the soil. However, in order for germination to occur there must be a sufficient seedbank present. Dewatering is also useful for facilitating planting activities if there is no seedbank; dry mudflats make it easier to manoeuvre over the planting site. An extensive discussion on the use and effect of drawdowns is provided in *Techniques for Wildlife Habitat Management of Wetlands*.

There are generally two main types of water control: permanent and short-term. Permanent structures can be very costly and usually require large-scale dykes and weirs to manipulate water levels. This technique tends to signify the long-term management of vegetation. Short-term techniques are relatively less expensive and are much smaller in scale. One small-scale technique involves the use of a water-filled polyethylene and geotextile barrier or Aqua Dam. The Royal Botanical Gardens in Hamilton, Ontario has found that these structures work best on dewatering small wetland areas. For more information on the Aqua Dam, refer to *Carp Control Techniques for Aquatic Plant Establishment*.

Protection of Plants

There are several possible problems that can limit plant establishment. These include: poor water quality, damage caused by wind and wave action, uprooting by fish (mainly carp), and trampling and herbivory from wildlife (e.g., deer, muskrat, rabbit, raccoon and various waterfowl). Although one objective of establishing new plants is to provide a source of food and habitat, it is necessary to maintain a plant population level that can sustain these uses. This level may be difficult to achieve with a large or steadily increasing fish and wildlife population.

Kirby Rogers

An exclosure with weld-wire fencing, T-bars and geotextile.

If large populations exist, it may be best to plant less palatable or desirable species. At Second Marsh in Oshawa a large area was planted with arrowhead, soft-stemmed bulrush, giant bur-reed, pickerelweed and water plantain (*Alisma plantago-aquatica*). After one to two months of growth, all plants except giant bur-reed were grazed. It is important to note that the desirable species and type of herbivores will vary from one site to another. Conducting trial plantings is useful for determining which plants are more susceptible to herbivory.

In addition to selecting species that are less palatable, a number of techniques will help protect plants and minimize their loss; however, the long-term effects of these techniques are unknown. The selection of a protection technique will vary depending upon site conditions and the species being planted. It may be best to use a combination of these techniques to achieve maximum results. A monitoring program should also be implemented to help identify the level of plant protection necessary and the species of wildlife that are consuming or trampling the plants.

Exclosures

Experience from several rehabilitation projects indicates that the use of exclosures will improve the survival of aquatic vegetation. One design for a fish, wildlife and sediment exclosure consists of four panels (2.43 metre square) made out of metal T-bars, weld-wire fencing and geotextile. The T-bars provide a frame to secure the fencing and geotextile. When assembled it resembles a pen-like structure keeping the plants safe from predators. The geotextile helps to reduce turbidity and wind and wave action within the exclosure. One of the shortcomings of this technique is the limited area that can be protected at one time. As well, it is difficult to predict what will happen to the vegetation when the exclosures are removed. For more details on exclosures, see *Carp Control Techniques for Aquatic Plant Establishment*.

Plastic fencing is another useful material for building exclosures. Installing plastic fencing is not as labour intensive because of its light weight, but it is less durable than metal fencing as muskrat can chew through the plastic links. When waterfowl are a concern, exclosures must be small enough to prevent landing. A standard sized exclosure (e.g., 2.43 metres square) will prevent the majority of waterfowl from entering. Plastic fencing makes it easier to section off larger areas (e.g., 10 square metres), but at this size waterfowl are able to land inside. To prevent landing, string rylon rope or flagging tape in parallel rows across the top and through the centre of the exclosure area. Then attach additional flagging tape or metal pie-plates at one metre intervals. This will help to scare away wildlife. If rope is used, regular monitoring is required to ensure that waterfowl do not become tangled. Rope and tape will also work if strung from nearby trees, shrubs or brush. It has been found that wildlife will become tolerant of the pie-plates, tape and rope after some time. For this reason, it is important to change these tactics every few weeks. Herbivores tend to be deterred by new objects.

Another exclosure method using string and wooden stakes is effective at deterring Canada geese and other waterfowl. Stakes are driven into the ground so they encompass the planting area. Several lines of string or thin rope are attached to the stakes creating a fence-like barrier. The first line of string should be started approximately 0.3 metres from the ground with each additional line being 0.3 metres above.[12]

Christmas Trees and Brush Piles

Christmas trees and brush piles are also useful for protecting aquatic plants. These trees are often available from municipal government roadside collection programs after the Christmas season. This technique involves randomly placing a single layer of trees throughout the entire planting area. There should be enough trees to cover approximately 75 per cent of the area. Positioning the trees during winter when the wetland is frozen will make it easier to manoeuvre around the planting area. When it comes time for planting, place the plants within and around the Christmas trees. The branches act as a barrier, inhibiting wildlife grazing and uprooting by carp. The trees also provide a means of trapping suspended sediments and seeds from nearby plants. This approach may not work well if there are strong currents or ice flows. As well, large areas may require fencing to limit movement of the trees.

Andy Ragen

Recycling Christmas trees at Second Marsh in Oshawa.

Planting Design

Another approach is to plant robust species in such a way that they protect more sensitive or palatable plants. The planting design is relatively simple. Less hardy species (e.g., arrowhead, water plantain) are completely surrounded in an exclosure like manner by more robust species such as cattails and giant bur-reed. These more durable plants protect the other species because they are more tolerant of a range of conditions including herbivory, trampling, poor water quality, and wind and wave action. Another strategy is to first establish the robust species, then place the other plants within and around the existing vegetation.

Approaches Requiring Permits

All of the above protection measures focus on excluding herbivores from areas with newly planted vegetation. Another approach to saving plants involves the removal or control of fish and wildlife populations. This generally consists of trapping for extermination or relocation and the destruction of nests or eggs. This type of protection requires permits or licensing from the government agency responsible for the species. It is important to note that direct control methods are controversial and may be opposed by various groups and organizations.

Plant Maintenance

Maintenance can be a costly expense which must be considered early in the planning stage. It largely depends on the size and complexity of the project site and who is involved. After planting maintenance may include removing undesirable species or building additional exclosures/barriers to inhibit vegetation herbivory or trampling. Selecting species that require as little care as possible and involving volunteers will help to lower costs.

KTCA

A learning experience – young volunteers in action.

Volunteers

Working with volunteers to help grow and plant vegetation is an excellent way to involve the local community. Volunteers can also help reduce the costs of a restoration project by assisting with seed collecting, processing, growing, planting and monitoring wetland vegetation; however, the success of the project tasks depends on proper training. This will maximize seed viability and plant survival. Local naturalist groups, conservation organizations and schools are excellent places to recruit volunteers. It can also be beneficial to develop a long-term volunteer stewardship program. These programs are useful for organizing volunteers and keeping them up-to-date with the project.

Do not over look the possibility of involving a local University or College. These institutions may have individuals with expertise and interest in these types of projects. Their research can help solve problems and determine the effectiveness of different techniques or the entire restoration project. It also provides an opportunity for students to obtain hands-on experience.

A Final Thought

Wetland restoration is a complex process requiring a considerable amount of time, effort and planning. This guide identifies a number of issues to consider when establishing aquatic vegetation. Throughout this guide are references and contacts to people and organizations who can offer further assistance. Some of the best insight on plant establishment is available from individuals involved with wetland restoration projects. The guide also includes a list of references and resources for further assistance.

It is important to realize that planting is not always appropriate or the only option. Sometimes it is best to facilitate natural colonization. If planting is preferred, remember to use materials that are native, of local origin and plant them in suitable habitats. When obtaining plant material, be sure to limit any adverse effects on the donor site. Remember, it is best to collect seeds and have them grown at a nursery. Stay informed of other restoration projects in the local area to limit collection from the same sites and follow the plant material collection guidelines.

Wetland restoration projects have the potential to involve various organizations and the surrounding community. Volunteers can help with collecting seeds, growing seedlings and planting. These types of projects help educate the community on the value of wetlands, build community support for their long-term protection and give individuals a personal connection to the community project. Above all, remember to have fun. The right attitude will get you through various dilemmas and help to ensure a successful project.

Common Marsh Plants

Emergent:	
water plantain	*Alisma plantago-aquatica*
swamp milkweed	*Asclepias incarnata*
sedges	*Carex* spp.
turtlehead	*Chelone glabra*
spike rushes	*Eleocharis* spp.
water horsetail	*Equisetum fluviatile*
wild blue flag	*Iris versicolor*
rushes	*Juncus* spp.
pickerelweed	*Pontederia cordata*
arrowhead	*Sagittaria latifolia*
hard-stemmed bulrush	*Scirpus acutus*
black bulrush	*Scirpus atrovirens*
softstem bulrush	*Scirpus validus*
green fruited bur-reed	*Sparganium chlorocarpum*
giant bur-reed	*Sparganium curycarpum*
cattails	*Typha* spp.
American brooklime	*Veronica americana*
Submergent:	
coontail	*Ceratophyllum demersum*
waterweed	*Elodea canadensis*
watermilfoil	*Myriophyllum exalbescens*
sago pondweed	*Potamogeton pectinatus*
pondweed	*Potamogeton richardsonii*
bladderworts	*Utricularia vulgaris*
tape grass	*Vallisneria americana*
Floating-leaved:	
yellow water lily	*Nuphar variegata*
white water lily	*Nymphaea odorata*
water smartweed	*Polygonum amphibium*
variable-leaved pondweed	*Pontamogeton gramineus*
floating pondweed	*Pontamogeton natans*
Free-floating:	
common duck weed	*Lemna minor*
star duckweed	*Lemna trisulca*
greater duckweed	*Spirodela polyrhiza*

Common Exotic Marsh Plants

Emergent:	
flowering-rush	*Butomus umbellatus*
great manna grass	*Glyceria maxima*
yellow flag	*Iris pseudacorus*
moneywort	*Lysimachia nummularia*
purple loosestrife	*Lythrum salicaria*
*reed canary grass	*Phalaris arundinacea*
marsh cress	*Rorippa amphibia*
*common reed grass	*Phragmites australis*
Submergent:	
Eurasian watermilfoil	*Myriophyllum spicatum*
curly pondweed	*Potamogeton crispus*
Floating-leaved:	
European frog-bit	*Hydrocharis morsus-ranae*
floating heart	*Nymphoides peltatum*

** Species with both exotic and native genotypes. It is difficult to distinguish these genotypes from one another, therefore it is better to avoid planting this species.*

Selected Growers of Native Aquatic Plants in Southern Ontario

This is not intended to be a complete list of native aquatic plant growers. Check local area listings for additional growers.

Big Creek Biota, R.R. #1,Walsingham, Ontario, N0E 1X0. Tel: (519) 586-2603 Fax: (519) 586-2447. Big Creek Biota maintains an abundance of wetland species (all grown from seed) in various vegetative forms including: tree, shrub, emergent, submergent, floating-leaved, free-floating and seed. Big Creek Biota will custom collect and contract grow native seeds. As well, site analysis and consultation services are available.

Chalk Lake Greenhouses, R.R. #4, Uxbridge, Ontario, L9P 1R4. Tel/Fax: (905) 649-5384. Chalk Lake Greenhouses has several species of wet meadow, emergent, submergent and floating-leaved plants available. Chalk Lake will also contract grow seeds.

Moore Water Gardens, P.O. Box 70, R.R. #4, Port Stanley, Ontario, N5L 1J4. Tel: (519) 782-4052 Fax: 1-800-728-6324. Moore Water Gardens maintains several species of emergent, submergent and floating-leaved aquatic plants.

Pterophylla, R.R. #1, Walsingham, Ontario, N0E 1X0. Tel/Fax: (519) 586-3985. Pterophylla provides native, local southern Ontario wet meadow and riparian species. They also have expertise in restoration and collecting and contract growing native seeds.

Picov's Water Garden Centre and Fishery, 380 Kingston Road East, Ajax, Ontario, L1S 4S7. Tel: 1-800-663-0300 Fax: (905) 686-2183. Picov's specializes in providing various species of herbaceous aquatic plants. All plants are propagated from seed and are available in many different forms. Contract growing is available. They also provide restoration and site analysis services.

Royal Botanical Gardens, 680 Plains Road West, Hamilton, Ontario, L8N 3H8. Tel: (905) 527- 1158 Fax: (905) 577-0375. The native aquatic plant nursery grows a variety of swamp, marsh and wet meadow species for restoration purposes. Seed is collected and grown on a contract basis. Consultation is sometimes available for wetland, forest and grassland restoration.

(*REMEMBER: Use local native plant material)

References

*(*reference or resource provides information on planting techniques)*

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Available from: Ontario Ministry of Natural Resources, Natural Resources Information Centre, Room M1-73, Macdonald Block, 900 Bay Street, Toronto, Ontario, M7A 2C1. Tel: (416) 314-2000.

2. Society for Ecological Restoration, Board of Directors. 1995. Definition of Ecological Restoration [working definition]. Madison: Society for Ecological Restoration.
Available from: Society for Ecological Restoration, 1207 Seminole Highway - Suite B, Madison, WI 53711 USA Tel: (608) 262-9547. Email: ser@vms2.macc.wisc.edu

3. *U.S. Army Engineer Waterways Experiment Station, Environmental Laboratory. 1978. Wetland Habitat Development with Dredged Material: Engineering and Plant Propagation. Vicksburg: U.S. Army. p. 69.
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